Prince George Region

Forest Resources & Practices Team

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FOREST

Lessons from Wildfire
Managing the Pattern of Forest Harvest

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One challenge facing today's forest managers is how to preserve biological diversity while maintaining a competitive forest industry. These two objectives are frequently at odds.

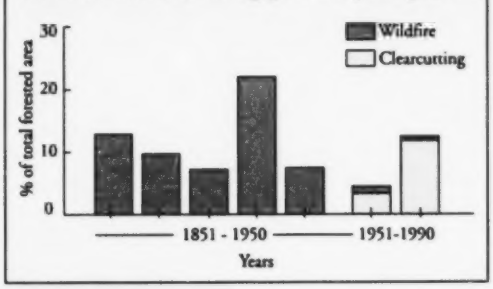
A new approach to landscape management in the Sub-Boreal Spruce (SBS) zone is suggested here. This approach calls for larger harvest units coupled with irregular boundaries, large leave areas outside the harvest zone, and many reserves of undisturbed timber within the harvested area. The goal is to create managed disturbances that more closely mimic the characteristics of wildfire disturbance.

Background

Traditionally, we have tried to preserve ecosystems by protecting selected land areas. The problem with this approach is that the protected areas are often chosen for their majesty and lack of conflict with established industry, primarily mining and forestry. The protected areas generally do not include the low elevation ecosystems that contain the greatest wildlife diversity and productivity and they are usually too small to protect wide-ranging species like grizzly bear and caribou. On the remainder of the landbase, the working forest, wildlife management guidelines are often aimed at providing habitat for a single species, such as moose.

In the wake of public criticism of past practices and a better understanding of natural systems, new ideas about forest management have emerged (Maser, 1988; Franklin, 1989; Hansen et al. 1991). One idea currently receiving attention is that managed disturbances should be designed to mimic natural disturbance regimes. This suggestion is based on emerging evidence of the important role that disturbance has played in forested ecosystems (Zackrisson 1977; Van Wagner 1978; Hessburg et al. 1994).

Figure 1. Total forested area disturbed by wildfire & clearcutting per 20-year period



The underlying assumption is that the plants and animals of the forest are adapted to the natural disturbance patterns created by wildfire Therefore, they should cope more easily with the ecological changes associated with timber harvesting, if those changes resemble natural disturbance patterns (Hunter, 1993; Swanson et al., 1993; Bunnell, in press).

Although current clearcut practices are said to mimic wildfire, there are some distinct differences between the characteristics of a landscape shaped by wildfire and a landscape shaped by forest harvesting. Those differences were the subject of a recent study.

Study methods & site description

The research was conducted on an area west of Prince George on the Nechako Plateau within the Salmon Valley variant of the Moist Cool Sub-Boreal Spruce (SBSmk1) biogeoclimatic unit.

The study explored the hypotheses that:

- wildfires are becoming smaller and less frequent.
- clearcutting has replaced wildfire as the dominant stand replacement agent in the study area.
- individual clearcuts are different in size, shape and distribution from individual wildfires.
- the landscape mosaic produced by clearcutting differs from that created by wildfire.

A number of databases were generated for this study using a Geographic Information System (GIS). These databases were used to examine different aspects of the temporal and spatial pattern of harvesting and wildfire at different scales. Various methods including aerial photography, forest inventory age information and ground truthing were used to characterize and interpret the study area.

Nine, 41 to 60 year old fire disturbances were selected for in-depth study. These nine wildfires represented a small proportion of the total number of wildfires in the area, but covered a relatively broad range of disturbance size. The nine study areas were surrounded by much older forest which made it easier to distinguish the boundaries of the wildfire disturbance. More recent

wildfires (1955 to the present) were excluded from this analysis because fire suppression activities and subsequent salvage logging would have significantly altered their character.

Natural vs. managed disturbances

Historically, wildfire has been the main stand replacement disturbance factor affecting the forests of plateau landscapes in the Prince George Forest Region. Harvesting has replaced wildfire as the dominant force shaping the forest landscape over the past 40 years (Figure 1).

Table 1. Recommended distribution of patch sizes (harvest units and leave areas)

Patch size (ha)	% Forest area within landscape unit
<40	10 - 20
40 - 250	10 - 20
250-1000	60 - 80

(Table 13, page 33, Biodiversity Guidebook)

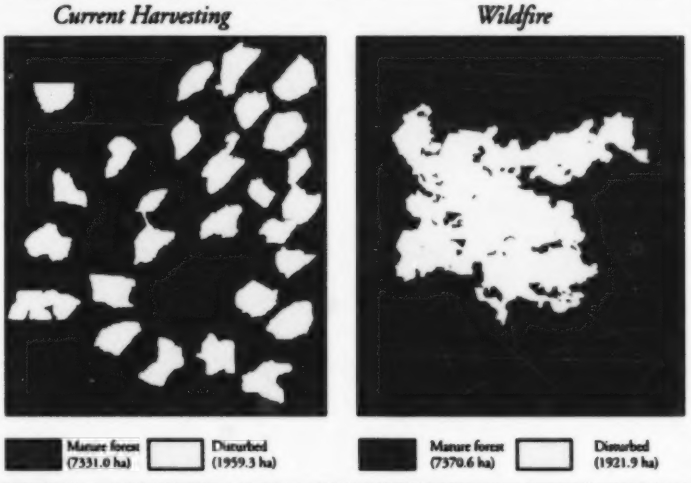
Some clear differences were observed in landscape and stand level patterns between harvesting and wildfire disturbances:

- The shapes of wildfire disturbance are much more complex than harvested openings.
- "Islands" of unburned timber usually remain undisturbed within the large fire burned openings.
- Large tracts of undisturbed mature forest often surround the fire disturbance area.

This is in marked contrast to the small, patchlike clearcut areas scattered widely across the landscape associated with harvesting (Figure 2).

Age selectivity: Wildfire is non selective regarding the age of the forest it disturbs, while harvesting occurs only in older stands. The forest industry's preference for older trees is not likely to change, so this basic difference will remain. However, other characteristics of a wildfire landscape pattern can be emulated by altering forest management practices.

Figure 2. Comparison of current harvesting and wildfire



Size and dispersal: Before 1950, an average of 12% of the total forested area would have been disturbed by wildfire during a 20 year period. That's roughly equal, to the area that has been disturbed by clearcutting in the past 20 years. In that same 20 years since 1970, only 0.15% of the total forested area was disturbed by wildfire.

Individual wildfires were generally quite large in the past. Figure 3 illustrates that prior to 1950, 50 to 75% of the total area of natural disturbance involved areas larger than 500 hectares. Since 1950, natural disturbance opening sizes have grown smaller. Firefighting has almost eliminated large scale wildfires in this area, though small fires are still common. The largest clearcut opening in the study area is 3,238 hectares compared to 32,273 hectares for a wildfire generated opening and more clearcuts are medium sized (100-500 ha).

The landscape habitat attributes (edge zone and interior forest area) of an individual wildfire and an area of recent harvest opening within the study area were compared. Edge zones represent the distance into the mature forest that is subject to the effects of being close to an edge. As suggested in the research literature, the size of the edge zone (100, 200 or 500 metres) varies for different species. Interior forest was defined as the amount of mature forest that is not subject to the edge effect. The landscapes dominated by small dispersed clearcuts were fragmented and had less of the interior forest habitat needed by certain wildlife species. The large, irregular patterns left by wildfire disturbance had more interior forest habitat, especially for 200 and 500 metre zones. This supports the idea that larger harvest units, accompanied by large leave areas should provide more interior forest for species such as woodland caribou (Table 1).

Forest management practices in the sub-boreal and boreal forests call for regularly dispersed clearcuts no greater than 60 hectares in size. However, there are now allowances under the Forest Practices Code for larger openings "if the district manager is of the opinion that the cutblock design is consistent with the structural characteristics and the temporal and spatial distribution of natural openings." (Section 21.3b, Forest Practices Code Regulations, April 1995)

In the past, large harvested openings were generally the unplanned outcome of salvage operations to remove timber damaged by bark beetle or blowdown. Since both of these events are somewhat predictable, it seems appropriate to allow larger harvest units to be part of the management plan. Altering plans to enable a proportion of larger and more irregular openings will reduce fragmentation. The result would be:

- a more natural range of patch sizes in the managed landscape.
- more interior forest retained along with large amounts of forest edge.
- fewer roads needed to manage harvesting operations, benefiting both wildlife and industry.

The overall result would be management by intent rather than management by default.

Shape:

Restricting cutblock size is one way to ensure favorable conditions for species that require edge habitat, such as moose. The other factor affecting edge is shape. The more irregular or complex the shape of an opening, the more edge is available to wildlife such as moose and deer.

The shape index is an indicator of shape complexity and is calculated using the formula:

$$SI = \frac{P_{\gamma}}{2\sqrt{\pi} \times \sqrt{a, 10{,}000}}$$

where SI = shape index, p = perimeter (metres), a = area (hectares)

When shape indexes were calculated for nine harvested and wildfire openings in the study area, the shape indexes were consistently higher for wildfire disturbances (40 to 62) than for harvested openings (approximately 20 to 26) (Figure 4). The shape index increased with wildfire size, while the shape index for harvested openings remained relatively constant throughout.

Increasing the shape complexity of larger harvested areas by creating more irregular cutblock boundaries would yield similar amounts of edge as the smaller, more geometric patterns currently employed.

The following Shape Index Targets for harvested forest openings are based on the wildfires studied.

Opening size (ha)	Shape index targets
50 to 100 ha	30 to 50
100 to 500 ha	50 to 60
>500 ha	>60

These shape index recommendations are consistently higher than the actual shape indexes of the harvested openings in the study area. To achieve the recommended targets, cutblock boundaries would have to be more irregular than conventional cutblocks. Incorporating natural boundaries such as riparian reserve edges, younger forest edges, non forested areas such as avalanche tracks or alder swales and low merchantability stands on rock outcrops or at high elevations are a few ways to increase the shape complexity of large harvest openings.

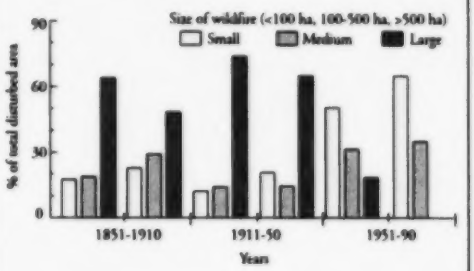
Island remnants:

Island remnants are areas of undisturbed timber within a wildfire disturbance. They provide valuable wildlife habitat and are likely important for reestablishment or maintenance of many organisms. They also provide a seed source for natural forest regeneration.

The position and size of island remnants was determined through examination of black and white air photos. These patches were categorized according to their size and landscape placement of wildlife tree patches.

Detailed mapping of the nine individual wildfires showed that island remnants comprised 3 to 15% of the total disturbed land area and that the proportion increased with the size of the fire (Figure 5). Individual island remnants ranged in size from less than 1 hectare to 73 hectares. In general, wildfires seem to compensate for their size by leaving more unburned remnants behind as they grow larger. The increase in remnant size following large fires is likely due to a combination of factors involving variable fuel supply, wind patterns and topography over a wide ranging area.

Figure 3. Size of wildfire disturbances as a percent age of total disturbed area, per 20-year period.



The distribution of wildlife tree patches over the topographic landscape varied considerably with each fire, but generally all of the landscape positions were represented. The amount of remnant area associated with lodgepole pine flats and draws (moisture receiving areas where the ground slopes up on at least 2 sides) was consistently high.

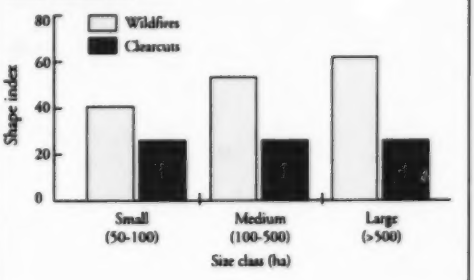
This suggests that it is important to represent all landscape positions when designing wildlife tree patches. For example, current research on bird use of remnants indicates that lodgepole pine trees are the preferred nesting site for some woodpecker species. Therefore, managers must strive to maintain remnants reflecting the full complement of biological diversity within large harvested openings.

Summary of recommendations

In landscapes similar to the study area, we recommend that:

- a significant proportion of the harvest area be in units larger than 250 hectares;
- harvest block shape be as irregular as operationally feasible;
- wildlife tree patches be maintained in all habitat types, including flat areas;
- wildlife tree patches be of varying sizes and shapes.

Figure 4. Comparison of shape complexity (wildfires vs clearcuts) in different size classes.



Conclusions

The wildfire study has produced some interesting comparisons between man made and natural disturbance patterns in the SBSmk1 subzone.

Assuming that forest harvesting activities will continue to exert their effects on the landscape, then it is important to consider methods that will more closely approximate natural disturbance patterns as a means of maintaining biodiversity over these landscapes.

The analysis reported here is likely applicable to large portions of sub-boreal and boreal forests where large stand replacing wildfire was frequent and where lodgepole pine is the dominant species. However, caution must be used in extrapolating these results too widely over other forest types, which may differ in the fire return patterns and wildfire intensity.

The approach suggested by this research would result in a proportion of larger, more irregular shaped openings accompanied by large leave areas in order to provide interior forest conditions. A significant portion of the landscape would be retained as island remnants as recommended in the Biodiversity Guidebook, page 65, Table 20a. These patches would vary in size and shape and would represent the full range of species and topographical types within the harvest area.

Because the history of harvesting in sub-boreal and boreal forests is relatively recent and localized, the potential still remains for such fundamental changes in resource management philosophy to occur. Time is of the essence though, because larger harvest units are difficult to enact in thoroughly fragmented forests.

There is a critical lack of empirical data to support our present system of dispersed clearcutting. Given the current state of knowledge, implementing larger harvest units which more closely mimic wildfire disturbance patterns, seems justifiable on both ecological and economic grounds. This approach may help achieve the required balance between ecological and economic sustainability in the future.

Ecological advantages

- Disturbance patterns resemble the natural disturbance patterns that biota are adapted to.
- Less forest fragmentation provides more interior forest habitat
- More abundant habitat components - hiding cover, course woody debris and snags - are available due to more uneven edge and retained patches.
- Human access to large areas are restricted and fewer roads are in use at any one time.

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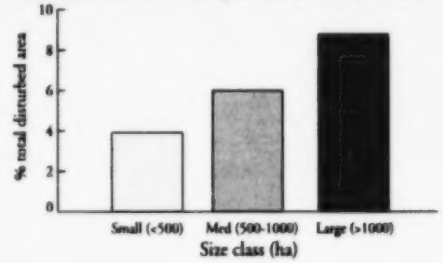
Economic benefits

- Less time is spent cleaning up blowdown from previously harvested areas. (Logical windfirm boundaries can be chosen when harvesting larger openings).
- Monitoring and administration by the Ministry and licencees is more efficient because forest operations are more concentrated and more manageable.
- The proportion of road and landing is less for larger openings. This reduces costs to industry and benefits many wildlife species.

If the public wishes to balance a competitive forest industry with biological diversity, then forest harvesting designed to resemble wildfire disturbances in sub-boreal plateau landscapes is one approach that might achieve a fairly even balance. This is important because much larger socio-economic or ecological compromises will be required in other forest landscapes, such as wet coastal or high elevation forests, where single tree death is the dominant force shaping the forest community.

Figure 5. Proportion of total disturbed area in island remnants, by size of disturbance.



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